DISPOSAL OF WASTE

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WASTE DISPOSAL

INTRODUCTION :

Man is behind every development endeavor. The large scale production and improper disposal of waste has become a source of pollution and further accumulation of garbage has resulted in serious deterioration in quality of life and the ecological balance. Many diseases like cholera and gastro-enteritis have been reported due to lack of proper collection and disposal of solid waste, insanitary condition and unsafe drinking water (Marudachalam, 1990).Now-a-days Public health engineers and other personnel's are facing a challenge of disposing the wastes which are increasing in mass by day by day. However, health professionals need to have a basic knowledge of the subject since improper disposal of wastes constitutes a health hazard. Further the health professional may be called upon to give advice in some special situations, such as camp sanitation or coping with waste disposal problems when there is a disruption or breakdown of community health services in natural disasters.

SOLID WASTES

It includes garbage, rubbish materials such as paper, wood, metal, glass etc., sewage treatment residues, dead animals and other discarded materials. Night soil is not included in solid wastes as strictly speaking.

Solid waste can be classified into different types depending on their source:

a) Household waste is generally classified as municipal waste,

b) Industrial waste as hazardous waste, and

c) Biomedical waste or hospital waste as infectious waste.

d) E waste

Health hazards of solid wastes:

- It decomposes and favors fly breeding

- It attracts rodents and vermin
- The pathogens which may be present in the solid waste may be conveyed back to man’s food through flies and dust.
- There is a possibility of water and soil pollution.
- Heaps of refuse present an unsightly appearance and nuisance from bad odors.

There is a correlation between improper disposal of solid wastes and incidence of Vector-borne diseases.

Municipal solid waste

Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is generated mainly from residential and commercial complexes. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. The solid waste generated in Indian cities has increased from 6 million tones in 1947 to 48 million tones in 1997 and is expected to increase to 300 million tones per annum by 2047 (CPCB, 2000). More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste.

In Tamil Nadu, the unsegregated municipal solid wastes generated are collected and are either disposed in low-lying areas or water bodies or disposed along the roadside and are set on fire causing air pollution. In Tamil Nadu due to urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. Chennai holds the second place in highest solid waste generation.

Type of litter	**Approximate time it takes to degenerate**
Organic waste such as vegetable and fruit peels, leftover foodstuff, etc.	a week or two.
Paper	10-30 days
Cotton cloth	2-5 months
Wood	10-15 years
Woolen items	1 year
Tin, aluminium, and other metal items such as cans	100 to 500 years
Plastic bags	one million years?
Glass bottles	Undetermined

General composition of the municipal solid wastes

Biodegradable matter	50%
Glass	4%
Plastics	3%
Paper	5%
Metals	1%
Leather and rubber	1%
Rags	5%
Household hazardous	1%
Inert materials	30%

Hazardous waste

Industrial and hospital waste is considered hazardous as they may contain toxic substances. Certain types of household waste are also hazardous. Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things e.g. gases**.** India generates around 7 million tonnes of hazardous wastes every year, most of which is concentrated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu.

Household waste that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles.

Hospital waste contaminated by chemicals used in hospitals is considered hazardous. These chemicals include formaldehyde and phenols, which are used as disinfectants, and mercury, which is used in thermometers or equipment that measure blood pressure. Most hospitals in India do not have proper disposal facilities for these hazardous wastes. In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries.

Hospital waste

Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biologicals. It may include wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner. It has been roughly estimated that of the 4 kg of waste generated in a hospital atleast 1 kg would be infected.

E-Waste

Electronic waste or E-waste as it is popularly called is a collective terminology for the entire stream of electronic wastes such as used TV's, refrigerators, telephones, air conditioners, computers, mobile phones etc. computer waste is the most significant of all waste due to the gigantic amounts as well as the rate at which it is generated. In addition, its recycling is a complex process that involves many hazardous materials and poses significant environmental and health hazard. E-waste is of particular concern to India currently. India is setting a shining example not only in the IT sector, but unfortunately, also in importing e-waste. E-waste contains over 1,000 different substances and chemicals, many of which are toxic and are likely to create serious problems for the environment and human health if not handled properly. E-waste contains many toxics such as heavy metals, including lead, cadmium, mercury, Polychlorinated Biphenyls (PCBs), Poly Vinyl Chloride (PVC), etc, in some components.

Management of Solid Wastes :

It consists of ,

a) Storage
b) Collection of refuses.

a) Storage :

- Proper storage is needed.
- The galvanized steel dust bin with close fitting cover is used.
- Public bins are also used.

b) Collection:

- House-house collection
- Public bins
- Open refuse carts should not be used.

Segregation of wastes:

As per UNEP report (1996) the Wastes can be segregated as,

i) Biodegradable and
ii)Non-biodegradable.

i) Biodegradable waste includes organic waste, kitchen waste, vegetables, fruits, flowers, leaves from the garden, and paper.

ii) Non-biodegradable waste can be further segregated into:

a) Recyclable waste – Plastics, paper, glass, metal, etc.

b) Toxic waste – Old medicines, paints, chemicals, bulbs, spray cans, fertilizer and pesticide containers, batteries etc.

c) Soiled – Hospital waste such as cloth soiled with blood and other body fluids.

Toxic and soiled waste must be disposed of with utmost care.

Methods of disposal :

The various methods used are,

a) Dumping
b) Controlled tipping
c) Incineration
d) Composting
e) Manure pits
f) Burial

A) Dumping :

It is a easy method. The refuse is simply dumped in to low lying areas. It also serves for reclamation of land. Bacterial action takes place and the refuse is converted to humus. The volume is decreased. There are certain drawbacks such as,

- Nuisance smell and unsightly appearance
- Exposed to flies and rodents
- The loose refuse is dispersed by the action of the wind

Drainage from dumps contributes to the pollution of surface and ground water. Most uncontrolled dumps are many years old, having grown over time from small dumps to large, unmanaged waste sites. Uncontrolled dumps have significant environmental impacts. As the waste decomposes, it creates leachate—a mix of toxic and nontoxic liquids and rainwater—which may get into local water supplies and contaminate the drinking water. Uncontrolled dumps also release gases that are explosive and flammable.

In some instances, waste is burned at these dumps, which poses a direct safety threat because of the danger of explosion. The air pollution created by burning harms local communities. Improper waste disposal also produces greenhouse gases (GHGs), which contribute to climate change.

A WHO Expert committee has condemned this method as a most insanitary method that creates public hazards, a nuisance, and severe pollution of the environment.

B) **Controlled tipping (Sanitary landfill) :**

It is the most satisfactory method of refuse disposal where suitable land is available. It differs from ordinary dumping in that the material is placed in a trench or other prepared area, adequately compacted and covered with earth at the end of the working day. The term, ‘Modified sanitary landfill’ has been applied to those operations where compaction and covering are accomplished once or twice a week.

The methods used are,

- **Trench method** - When level ground is available, this method is usually chosen. A long trench of 2 – 3 mt deep and 4 – 12 mt wide is dug out. The refuse is compacted and covered by excavated earth. It is estimated that one acre of land per year will be required for 10,000 population.
- **Ramp method** – well suited for sloping terrains. Only little excavation is done here to secure the covering material.
- **Area method** – It is used for filling land depressions, disused quarries and clay pits. The refuse is deposited, packed and coalesced in uniform layers up to 2.5m deep. Each layer is sealed on its exposed surface with a mud cover for 30cm thick. This method requires additional earth from outside sources. Such sealing prevents infestation by flies, rodents and suppresses the nuisance of smell and dust.Physical, chemical and bacteriological changes occur in buried refuse. In a week’s time the temperature rises to over 60 deg. C within 7 days and kills all pathogens and hastens the decomposition process. It takes 2 – 3 weeks to cool down. Usually it takes about 4 to 6 months for complete decomposition of organic matter.

C) Incineration :

When suitable land is not available, incineration or burning is the choice. Dangerous hospital wastes are best disposed by incineration. It is practiced in several of the industrialized countries, particularly in large cities due to lack of suitable land. A preliminary separation of dust and ash from the refuse is done. Then it is incinerated. The process is usually selected to treat wastes that cannot be recycled, reused or disposed off in a land fill site.

D) **Composting :**

Composting is a biological process in which microorganisms, mainly fungi and bacteria, convert degradable organic waste into a humus-like material called Compost. It is the combined method of refuse and night soil disposal. This finished product, which looks like soil, is rich in carbon and nitrogen and is an excellent medium for growing plants. The process of composting ensures that kitchen waste - a significant contributor of every household's bulky volume of garbage - is not thrown, only to be mixed up with hazardous or recyclable rubbish. Apart from being clean, cheap and safe, coupled with the inherent quality of household replication, composting can significantly reduce the amount of disposable garbage.

It has the manorial value for the soil. Co_2, heat and water are the byproducts. The heat evolved during composting is around 60 deg C. over a period of several days, the eggs, flies, pathogenic agents etc. are destroyed. The final product compost contains few or no pathogenic agents. It contains minor amounts of nitrates and phosphates and is used as a soil builder.

Methods used:

i) Bangalore method - Anaerobic method

ii) Mechanical composting - Aerobic method

Bangalore method –(Anaerobic method) :

This hot fermentation process method has been devised by the Indian Council of Agricultural Research, in Bangalore.It has been recommended as a satisfactory method of disposal of town wastes and night soil.

Trenches of 90 cm deep,
1.5 – 2.5 m broad
4.5 – 10 m long are dugged.

The pits should be located more than 800 m from city limits.

Procedure:

- A layer of refuse about 15cm thick is spread at the bottom of the trench.
- Night soil of 5 cm thickness is added over this layer.
- Then alternate layer of refuse (15 cm thick) and night soil (5 cm thick) are added.
- This is done till the heap rises to about 30 cm above the ground level.
- The topmost layer should be the refuse of 25 cm thickness
- Then the heap is covered by excavated earth.

Within seven days as a result of bacterial action, heat over 60 ℃ will be generated in the mass of compost. This will persist for 2 – 3 weeks, decompose the refuse and night soil and destroy all pathogenic and parasitic agents. For the complete decomposition it will take 4 – 6 months. The resulting manure is innocuous, odorless material of high manorial value.

Mechanical composting:

This method consists of literally manufacturing the compost on a large scale. The raw materials have been processed and turned out to a finished product.

- Salvageable materials such as metal, glass etc. are first cleared from the refuse.
- It is then pulverized in a pulverizing equipment to reduce the particle size less than 2 inches.
- The pulverized refuse is then mixed with sewage, night soil in a rotating machine and brooded.
- In 4 – 6 weeks the composting will be complete.
- In India it is under installation procedure.

Large scale composting may be generally attractive to municipal waste authorities for several reasons, the two most important being - saving landfill space and returning organic matter to the soil. Composting is not generally a profitable process. Karnataka has its own state supported compost development corporation. Yet, worldwide municipalities have found that the composting process only becomes financially viable when alternative methods of disposal are less attractive. In countries where the cost of landfill has risen above the composting cost threshold, composting presents an attractive disposal option. Manufacturing good compost in large-scale quantities from municipal wastes demands several primary ingredients:

- a secure land to accommodate the process
- planning permission and utilities sufficient for the process
- a regular supply of uncontaminated waste as feed stock
- reliable size reduction machinery
- a homogenizing and maturing system
- a screening system
- a firm market for the products produced and
- feasible financial arrangements.

E) Manure pits :

In rural areas such as village, there is no system of collecting wastes. Refuse is thrown indiscriminately causing soil pollution. Manure pits are dig by individuals in their houses.

All the refuse are dumped in to this and closed by earth after each day's dumping. Usually two pits are to be dig. While one is closed, the other will be for use. After 5 – 6 months time, the refuse is converted in to manure.

E) **Burial :**

A trench of 1.5 m wide and 2 m deep is excavated and at the end of each day, the refuse is covered with 20 – 30 cm of earth. When the level in the trench is 40 cm from ground level, the trench is filled with earth and closed. A new one is dug out. The contents are taken out after 4 – 6 months and used as a manure.

Public education is a essential tool in solving this solid wastes disposal problems. Health education via various methods will help in solving this problem for ever.

In a study conducted by H M P Fielder et al, 2000, There was an increased maternal risk of having a baby with a congenital abnormality in residents near the site, both before its opening (relative risk 1.9; 95% confidence interval 1.3 to 2.85; $P < 0.001$) and after (1.9; 1.23 to 2.95; $P = 0.003$). Environmental monitoring showed that hydrogen sulphide from the site was probably responsible for odors.

Plastic and Waste Management Issues:

It is estimated that approximately 4-5 % post-consumer plastics waste by weight of Municipal Solid Waste (MSW) is generated in India.

As per data available on MSW, approximately, 4000-5000 tones per day post consumer plastics waste is generated, however, pre-consumer waste or scrap is directly utilised in the industry itself. The plastics waste constitutes tow major category of plastics; (1) Thermoplastics' and (2) Thermoset plastics.

The Thermoplastics are recyclable plastics which include; PET, PVC, HDPE, PP, PS etc., however, Thermoset plastics contains Alkyd, Epoxy, Ester, Melamine Formaldehyde, Phenolic Formaldehyde, Silicon, Urea Formaldehyde, Polyurethane, Metalised and Multilayer Plastics etc. The major problem in plastics waste management is of collection, segregation and disposal. At present, the plastics waste disposal is done through unorganised sectors i.e. Ragpickers and Kabariwaslas.

More importantly, the collection, segregation and to an extent disposal system is carried out through unscientific method which create environmental problem as well as an "Eyesore". Therefore, there is need to reorganise whole recycling process and in this context, CPCB has enlightened this issue to a extent by developing new recycling technique as well as developed innovative technologies for disposal of plastics waste such as "utilisation of plastic waste in road construction" and "re-engineering the recycling process".

EXCRETA DISPOSAL

Human excreta are a source of infection. It is an important cause of environmental pollution. Nearly 74% of India's population live in rural areas and the majority of them 'go to the fields' for defecation and thereby pollute the environment.

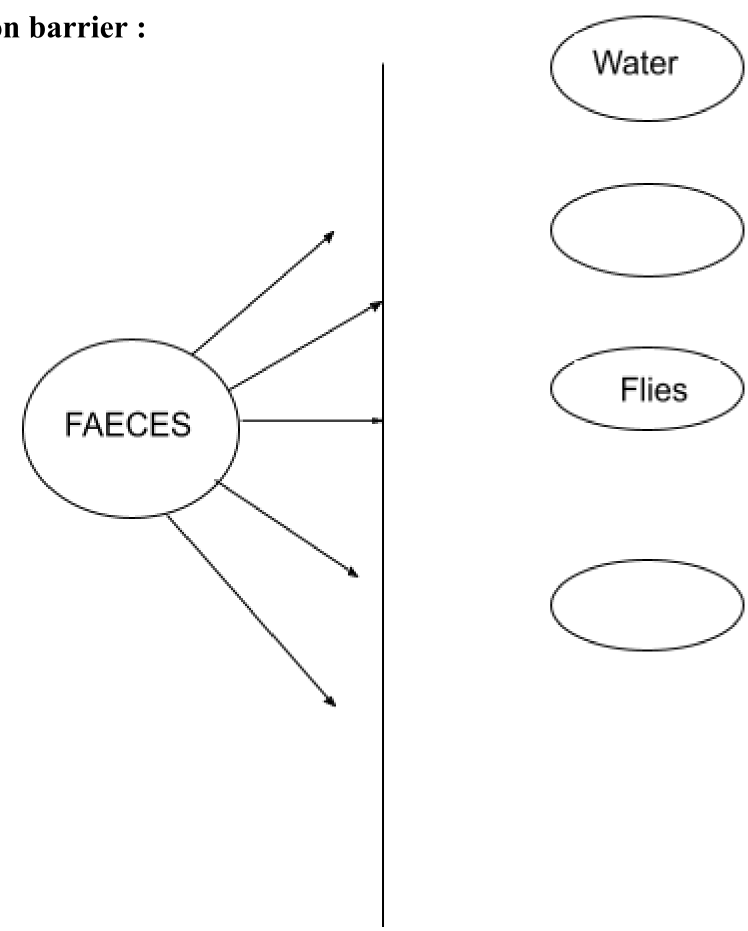
Health hazards :

The health hazards are soil pollution, water pollution, contamination of foods and propagation of flies. The resulting diseases are typhoid, paratyphoid fever, dysenteries, diarrhoeas, cholera, hookworm disease, ascariasis etc. Statistics indicate that the intestinal group of diseases claim about 5 million lives per year while another 50 million people suffer from these infections.

Channels of transmission :

Water, fingers, flies, soil and food.

Sanitation barrier :



Community medicine aims at breaking the disease cycle at vulnerable points. It may be broken at various levels – Segregation of faeces, protection of water supplies, protection of foods, personal hygiene and control of flies.

Of these the most effective step would be to segregate the faeces and arrange for its proper disposal. This sanitation barrier can be provided by 'Sanitation latrine' and a disposal pit.

Excreta disposal in unsewered areas :

a) Service type latrines (Conservancy system)

The collection and removal of night soil from bucket or pail latrines by human agency is called the service type and the latrines are called service latrines. The night soil is transported in carts to the place of final disposal, where it is disposed by composting or burial in shallow trenches.

Drawbacks :

It is a source of filth and insanitation.

b) Non-service type latrines (Sanitary latrines)

Criteria for sanitary latrines :

Excreta should not

- contaminate the ground or surface water.
- pollute soil.
- Be accessible to flies, rodents and animals
- Create a nuisance due to odour or unsightly appearance

Some of the well known types of sanitary latrines are Bore hole latrine, Dug well latrine, Water seal latrine and RCA latrine.

Bore hole latrine :

It was introduced by Rockefeller foundation during 1930's in campaigns of hookworm control. It consists of a circular hole 30-40 cm in diameter, dug vertically into the ground to a depth of 4-8 mts. A suitable enclosure is put up to cover it.

The night soil undergoes purification by anaerobic digestion and is eventually converted into a harmless mass.

Drawbacks :

It fills up rapidly because of its small capacity and in many places the subsoil water is high and the soil loose, difficult to dig a hole deeper.

Dug well latrine :

It was introduced first in west Bengal. A circular pit about 75cm in diameter and 3-3.5 m deep is dug into the ground for the reception of the night soil. The pit may be linked with pottery rings, and as many rings as necessary to prevent caving in of the soil may be used. A concrete plate is placed on the top.

Advantages :

It is easy to construct. The pit has a longer life.

Water seal latrine :

A further improvement in the designing of sanitary latrines for rural families is the hand –flushed "water seal" type of latrine. Here, the squatting plate is fitted with a water seal. The water seal serves two functions – it prevents access by flies. It also prevent escape of odours and gases.ex. RCA latrine.

SEWAGE DISPOSAL

Sewage is waste water from a community, which consists of solid and liquid excreta, derived from houses, street and yard washings, factories and industries. Sewage flow is not uniform throughout the day. The average amount of sewage flowing through the sewerage system in 24 hours is called as "Dry weather flow". Waste water which is free of human excreta is called as "Sullage".

Composition:

Water	-	99.9%
Solids (organic and inorganic)	-	0.1%

It consists of numerous micro-organisms derived from the human faeces. Decomposition of organic matter (aerobic and anaerobic processes) leads to offensive odour. To determine the organic content in sewage "Bio-chemical Oxygen Demand" (BOD) test is done. It is the amount of Oxygen absorbed by a sewage sample over a specified period of time.

For natural wastes BOD range - 1mg/L

For untreated Domestic wastage - 300mg/L

If the sewage consists of Toxic substances, the practical method for determining the organic content is the "Chemical Oxygen Demand" (COD) test. It measures the oxygen equivalent of that portion of the organic matter in a sample which is susceptible to oxidation by a strong oxidizer.

Aims of sewage treatment:

- To stabilize the organic matter, so that it can be safely disposed.
- To convert the sewage water to purity of acceptable standards.

Treatment of sewage:

The treatment method consists of purification of sewage by the action of aerobic and anaerobic bacteria. It consists of two stages.

Treatment of sewage

Primary treatment

- Screening
- Grit chamber
- Primary sedimentation

Secondary treatment

- Biological treatment
- Final sedimentation

Primary treatment:

a) Screening – it consists of metal screen intercepting the sewage for large floating objects. It may be of fixed or removable type. The screens are removed from time to time either manually or mechanically, and are disposed off by trenching or burial.

b) Grit chamber –The sewage is passed through this chamber which allows the heavier solid things to settle down, while allowing the organic matters to pass through. The grit collected is periodically removed and disposed off by plain dumping or trenching.

c) Primary Sedimentation – The sewage is passed slowly at the velocity of 1 – 2 feet per minute through a large tank. Purification takes place by sedimentation. The organic matter which settles down by the influence of gravity is called as Sludge. Certain amount of biological action also takes place. A certain amount of fats and grease forms at the surface called as Scum. Sludge and Scum are periodically removed. Addition of chemicals such as lime, aluminium sulphate and ferrous sulphate precipitates the animal proteins present in sewage.

SCREENING

GRIT CHAMBER

Secondary treatment:

After the primary treatment also the sewage material consists of organic matters. Further treatment consists of oxidation process by one of the following methods.

- Trickling filter method
- Activated sludge process

Trickling filter method:

It consists of a bed of crushed stones and rotating hollow pipes. A thin film called as “Zoogleal layer” consisting of algae, fungi, bacteria etc exists on the surface of the filter bed. It oxidizes the effluent from the primary treatment chamber. Thus the action is more biological one.

Activated sludge process:

It is the modern method adopted now-a-days. It consists of aeration tank. Aeration of the effluent can be done by two methods – mechanical or by compressed air (Diffuse aeration). By this the organic matters are oxidized in to Co_2, nitrates and water.

It is then passed to secondary sedimentation tank, where it is detained for 2 – 3 hours. The sludge which is collected after this is called as “aerated sludge”. It is a valuable manure.

Most of the modern sewage treatment plans digest the sludge produced during the process.

AERATION OF THE EFFLUENT

Secondary sedimentation

The oxidized sewage from the trickling filter or aeration chamber is led into the secondary sedimentation tank where it is detained for 2-3 hours. The sludge that collects in the secondary sedimentation tank is called aerated sludge or activated sludge, because it is fully aerated. It differs from the sludge in the primary sedimentation tank in that it is practically inoffensive and is rich in bacteriae, nitrogen and phosphates.

Sludge digestion :

One of the greatest problems associated with sewage treatment is the treatment and disposal of the resulting sludge. One million gallons of sewage produces 15-20 tons of sludge. The sludge is a thick, black mass containing 95% of water and it has a revolting odour. There are a number of methods for sludge disposal.

a) Digestion :

Modern sewage treatment plants employ digestion of sludge as the method of treatment. If sludge is incubated under favourable conditions of temperature and pH, it undergoes anaerobic auto-digestion in which complex solids are broken down into water, co_2, methane and ammonia. The volume of sludge is also considerably reduced. It takes 3-4 weeks or longer for complete sludge digestion.

The residue is inoffensive, sticky and tarry mud which will dry readily and form an excellent manure. It is carried out in special tanks known as ‘Sldge digestion tanks’. Methane gas which is a byproduct of the process, can be used for heating and lighting purposes.

b) Sea disposal :

Sea coast towns and cities can dispose of sludge by pumping it into the sea.

c) Land :

Sludge can be disposed of by composting with town refuse.

Effluent disposal:

The effluent is well chlorinated and diluted in the water. The impurities in the effluent will be oxidized by the oxygen content of water. Otherwise it is disposed in land as a part of irrigation.

Other methods of sewage disposal:

a) Sea outfall :

Sea coast towns and cities may dispose of their sewage by discharging it into the sea. Purification takes place by dilution in the large body of sea water, and the solids get slowly oxidized. The drawback of this method is that the offensive solid matter may be washed back to the shore and create public nuisance.

b) River outfall :

Raw sewage should never be discharged into rivers. The present day practice is to purify the sewage before it is discharged into rivers. How far the sewage should be purified depends upon the dilution the river provides to carry on aeration and self-purification.

c) Oxidation ponds :

The other names are waste stabilization pond, redox pond, sewage lagoons etc. the waste includes both sewage and industrial wastes. Over 50 ponds are working in India.

The oxidation pond is a open, shallow pool 1 to 1.5 mt deep with an inlet and outlet. To qualify as an oxidation pond, there must be the presence of – algae, certain types of bacteria which feed on decaying organic matter and sunlight. The organic matter contained in the sewage is oxidized by bacteria to simple chemical compounds such as co_2, ammonia and water. The algae with the help of sunlight, utilize the $co_{2,}$ water and inorganic minerals for their growth. Thus there is a mutually beneficial biological balance between the algae and bacteria in oxidation ponds. Oxygen that is needed for oxidation is derived from atmosphere and also from algae. The bottom layers are anaerobic. Thus the sewage purification is brought about by aerobic and anaerobic types of bacteria.

d) Oxidation Ditches :

This method makes use of mechanical rotors for extended aeration. For treatment of the wastes of a population between 5,000 to 20,000 an oxidation ditch requires an area of one acre as compared to 22 acres for an oxidation pond.

Hospital waste management

Hospital wastes have always been considered as potentially hazardous in view of the inherent potential for dissemination of infection. The major identified hazard was that of infection, because over millennia communicable diseases had been the most common cause of morbidity and mortality in the community and majority of persons receiving treatment in the hospitals were suffering from communicable diseases. The waste produced in the course of health care activities carries a higher potential for infection and injury than any other types of waste. Therefore, it is essential to have safe and reliable method for it's handling. Inadequate and inappropriate handling of health care waste may have serious public health consequences and a significant impact on the environment. Appropriate management of health care waste should become an integral feature of health care services.

Bio-Medical waste :

According to Bio-medical waste (management and Handling) Rules, 1998 of India, ***"Bio-Medical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of Biologicals".***

Between 75-90% of the waste produced by the Health care providers is non-risk or General health care waste, compared to domestic waste. Most biomedical waste generated from health care facilities are at present, collected without segregation into infectious and non-infectious categories and are disposed in municipal bins located either inside or outside the facility premises. Sanitary workers pick this waste from here along with MSW and transport and dispose it at municipal dumpsites. Since the infectious waste gets mixed with municipal solid waste, it has potential to make the whole lot infectious in adverse environmental conditions.

Sources of Health care waste :

Government and private hospitals, Nursing homes, Dispensaries, Primary health centre, Medical research and training establishments, Mortuaries, Animal houses, Blood banks and Collection centres, slaughter houses, laboratories, Vaccinating centres, Bio-technology institutions etc.

Health care waste generation :

In middle and low income countries health care waste generated is lower than in high income countries.

The average distribution of health care wastes in developing countries are estimated as follows :

- 80% of general health care waste, are dealt with normal domestic and urban waste management system
- 15% are pathological and infectious waste
- 1% sharps waste
- 3% chemical and pharmacological waste
- Less than 1% special waste, such as radioactive or cytotoxic waste etc.

Health hazards of Health care waste :

All individuals exposed to such hazardous health care waste are potentially at risk, including those who generate the waste or either who handle such waste.

Pathogens in infectious waste may enter the human body through a puncture, abrasion or cut in the skin, through mucous membranes by inhalation or ingestion. There is a strong evidence that HIV, Hep.B and C transmission via health car waste. Many of the chemicals and pharmaceuticals used in health car establishments are toxic, genotoxic, flammable, reactive, explosive. Although present in small quantity they may cause intoxication, either by acute or chronic exposure and injuries, including burns.

Genotoxic wastes exposure via inhalation, absorption through the skin may cause damage. The damage due to genotoxic/radio-active wastes is determined by the type and quantity of exposure.

Health care waste disposal :

Incineration used to be the method of choice for most hazardous health care wastes.

a) Incineration :

When suitable land is not available, incineration or burning is the choice. Dangerous hospital wastes are best disposed by incineration. A preliminary separation of dust and ash from the refuse is done. Then it is incinerated. The process is usually selected to treat wastes that cannot be recycled, reused or disposed off in a land fill site. The final choice of treatment should be made on the basis of factors, many of which depend on local Conditions. However recently developed alternative methods are becoming popular. It has limited application in India since by burning we are losing the manure.

"It is a high temperature dry oxidation process that reduces organic and combustible waste to inorganic incombustible matter and results in a very significant reduction of waste volume weight".

Wastes suitable for incineration :

- Low heating volume
- Content of combustible matter above 60%
- Content of non combustible solids below 5%
- Content of non combustible fines below 20%
- Moisture content below 30%

Waste types not to be incinerated :

- Pressurized gas containers
- Large amount of reactive chemical wastes
- Silver salts, radiographic and photographic wastes
- Halogenated plastics such as PVC
- Waste with high mercury or cadmium content, ex. Broken thermometers, used batteries
- Ampules containing heavy metals.

Types of incinerators :

Incinerators can range from vary basic combustion unit that operates at much lower temperature to extremely high temperature operating plants. It should be carefully chosen on the basis of available resources, the local situation and risk-benefit consideration.

Three types of incinerators are there :

1.Double chamber pyrolytic incinerators specially designed to burn infectious health care waste.

2. Single chamber furnaces with static gate used, if pyrolytic incinerators are nor affordable

3.Rotary kilns operating at high temperatures, capable of causing decomposition of genotoxic substances and heat-resistant chemicals.

Medical waste incineration is a major source of dioxins. Polyvinyl chloride (PVC) plastic, as the dominant source of organically bound chlorine in the medical waste stream, is the primary cause of "iatrogenic" dioxin produced by the incineration of medical wastes. Health professionals have a responsibility to work to reduce dioxin exposure from medical sources. Health care institutions should implement policies to reduce the use of PVC plastics, thus achieving major reductions in medically related dioxin formation.

b) Chemical disinfection :

Chemicals are added to waste to kill or inactivate the pathogens it contains, usually results in disinfection rather than sterilization. Chemical disinfection is suitable for treating liquid waste such as Blood, urine, stools or hospital sewage. However solid wastes including microbiological cultures, sharps etc. may also be disinfected chemically with certain limitations.

c) Wet and Dry thermal treatment :

Wet thermal treatment is based on exposure of shredded infectious waste to high temperature, high pressure steam, and is similar to the autoclave sterilization process. This method is inappropriate for anatomical wastes and animal carcasses and not efficient to treat chemical or pharmacological waste.

Screw-Feed technology is the basis of a non-burn, dry thermal disinfection process in which waste is shredded and heated in a rotary auger. This process is not suitable for treating infectious waste and sharps, but it should not be used to process pathological, cytotoxic or radioactive waste.

d) Microwave irradiation :

Most micro-organisms are destroyed by the action of microwave of frequency about 2450MHz and a wavelength of 12.24cm. The water contained within the waste is rapidly heated by the microwaves and the infectious components are destroyed by heat conduction.

e) Land disposal :

If a municipality or medical authority genuinely lacks the means to treat waste before disposal, the use of landfill has to be regarded as an acceptable disposal route. There are two types, Open dumps and Sanitary landfills.

Advantages of Sanitary landfill :

Geological isolation of wastes from the environment, appropriate preparation of the site before it receives the waste, staff is present on site to control operations and organized deposit and daily coverage of waste.

f) Inertization :

The process of Inertization involves mixing waste with cement and other substances before disposal, in order to minimize the risk of toxic substances contained in the wastes migrating into the surface or ground water.

A typical proportion of the mixture is: 65% pharmaceutical waste, 15% lime, 15% cement and 5% water. A homogenous mass is formed and cubes or pellets are produced on site and then transported to suitable storage sites.

Legislation :

Bio-medical waste (Management and Handling) rule 1998, came into force on 28th july 1998.

Category	*Type container*	*Color coding*
1. Human anatomical waste	**Plastic bag**	**Yellow**
2. Animal waste	**Plastic bag**	**Yellow**
3. Micro and biotechnology waste	**Plastic bag**	**Yellow / Red**
4. Waste sharp	**Plastic bag puncture proof container**	**Blue / white**
5. Discarded medicine and cytotoxic waste	**Plastic bag**	**Black**

6. Solid waste (soiled)	**Plastic bag**	**Yellow** / **Red**
7. Solid waste (plastic)	**Plastic bag puncture proof container**	**Blue** /**white** translucent
8. Liquid waste	**Plastic bag puncture proof container**	**Blue** /**white** translucent
9. Incinerator ash	**Plastic bag**	**Black**
10. Chemical waste	**Plastic bag**	**Black**

Dental waste management

Wastes commonly generated in dental offices include amalgam particles, waste mercury, fixers, developers, x-ray film packets and chemiclave chemicals. Contaminated items that may contain the body fluids of patients, such as gloves and patient napkins, should be placed in a lined thrash receptacle. Receptacles for contaminated waste should be covered with a properly fitted lid that can be opened with a foot pedal. Keeping the lid closed prevents air movement and the spreading of contaminants. This receptacle should not be overfilled, and it should be emptied out a minimum of once daily. Containers of infectious waste must be labeled with the universal biohazard symbol, identified in compliance with local regulations, or both.

Amalgam

Dental amalgam contains both mercury and silver and therefore must be properly handled. It cannot be mixed with biomedical waste because if incinerated, mercury is released into the air. The waste must never be put in the regular trash; rather it must be sent to a mercury reclaimer or a hazardous waste management company. Limiting the amount of amalgam used to the smallest appropriate size for each restoration can reduce the amount of waste generated.

Elemental Mercury

Mercury can be found in dental offices for use in amalgam. It is very toxic and should be handled with care. Waste mercury should be disposed of through a licensed mercury reclaimer or hazardous waste management company.

X-ray Fixer

Used x-ray fixer is a hazardous waste due to its high silver content. Spent fixer solution contains approximately 4000 mg of silver per litre. It should not be mixed with developer or disposed of down the drain. Instead, it can be sent to a silver reclaimer or hazardous waste management company. Some film companies or photo processing centers will accept the used chemicals for recycling. Utilize a digital X-ray unit to minimize the need for fixer solutions. Another option is to install a silver recovery unit or pay someone who operates one to take the fixer.

X-ray Film

Used and unused x-ray film contains silver which should be recycled if no longer needed. Many film suppliers offer recycling programs and may accept unused film.

X-ray Developer

Spent developer alone can usually be disposed of through the wastewater treatment system with permission from your local wastewater authority. Developer should not be disposed of through a septic system. Never mix fixer with developer. Unused developer and developer that has been mixed with fixer should be handled as hazardous waste.

Lead Foil Packets

Film packets contain lead, a hazardous material that should be disposed of through a metal recycler or as hazardous waste. Many film suppliers accept used foil packets. Some recycling companies may be willing to work with dentists to recover lead from foil packets or lead aprons.

Sterilant Solutions

Depending on concentrations or ingredients, many chemical disinfectant solutions may be classified as hazardous waste. Lab tests, MSDS sheets, and vendor information may be helpful in determining the hazardous nature of these wastes. Never discharge sterilant solutions into septic systems, and check with the local wastewater treatment plant to determine if the chemiclave may be disposed of into the sewer system. Consider switching to autoclave or a less toxic solution. Additionally, only buy and use the amount of sterilant needed. Sterilant absorbed on cloths or paper products is acceptable as regular solid waste.

Dental Amalgam Traps

Disposable amalgam traps are preferred over reusable traps because it is difficult to clean the reusable traps without releasing amalgam into the sewer or garbage. Disposable traps should be changed weekly or more frequently if needed, or as recommended by the manufacturer of equipment. Be sure to flush the vacuum system before changing the chair-side trap.

If reusable amalgam traps are used, take the following steps:

1) Disinfect the traps using a minimum amount of disinfectant.

2) Remove visible scrap amalgam from the reusable amalgam trap and store it in an airtight container as directed by the waste hauler or recycler.

3) Use the appropriate protective equipment when handling amalgam.

4) Never rinse the trap over drains or sinks.

Waste management -- reasons for failure

The absence of waste management, lack of awareness about the health hazards, insufficient financial and human resources and poor control of waste disposal are the most common problems connected with health-care wastes. Many countries do not have appropriate regulations, or do not enforce them. An essential issue is the clear attribution of responsibility of appropriate handling and disposal of waste. According to the 'polluter pays' principle, this responsibility lies with the waste producer, usually being the health-care provider, or the establishment involved in related activities.

In the last few years there has been growing controversy over the incineration of health-care waste. Under some circumstances, including when wastes are incinerated at low temperatures or when plastics that contain polyvinyl chloride (PVC) are incinerated, dioxins and furans and other toxic air pollutants may be produced as emissions and/or in bottom or fly ash (ash that is carried by air and exhaust gases up the incinerator stack). Exposure to dioxins, furans and co-planar PCBs may lead to adverse health effects.

Health concerns and intake limits :

Long-term, low-level exposure of humans to dioxins and furans may lead to the impairment of the immune system, the impairment of the development of the nervous system, the endocrine system and the reproductive functions. Short-term, high-level exposure may result in skin lesions and altered liver function.

WHO has established a Provisional Tolerable Monthly Intake (PTMI) for dioxins, furans, and polychlorinated biphenyls (PCBs) of 70 picograms (10^{-12} g) per kilogram of body weight. The PTMI is an estimate of the amount of chemical per month that can be ingested over a lifetime without appreciable health risk. Almost all exposure to dioxins and furans is through the food chain and the PTMI represents the cumulative exposure to dioxins and furans from all sources including food and water.

Incorrect disposal of health-care waste creates other health risks :

The unsafe disposal of health-care waste (for example, contaminated syringes and needles) poses public health risks. Contaminated needles and syringes represent a particular threat as the failure to dispose of them safely may lead to dangerous recycling and repackaging which lead to unsafe reuse. Contaminated injection equipment may be scavenged from waste areas and dumpsites and either be reused or sold to be used again. WHO estimated that, in 2000, contaminated injections with contaminated syringes caused:

- 21 million hepatitis B virus (HBV) infections (32% of all new infections);
- two million hepatitis C virus (HCV) infections (40% of all new infections); and
- atleast 260 000 HIV infections (5% of all new infections).

In 2002, the results of a WHO assessment conducted in 22 developing countries showed that the proportion of health-care facilities that do not use proper waste disposal methods ranges from 18% to 64%.

In addition to the public health risks, if not managed, direct reuse of contaminated injection equipment results in occupational hazards to health workers, waste handlers and scavengers. Where waste is dumped into areas without restricted access, children may come into contact with contaminated waste and play with used needles and syringes. Epidemiological studies indicate that a person who experiences one needle stick injury from a needle used on an infected source patient has risks of 30%, 1.8%, and 0.3% respectively of becoming infected with HBV, HCV and HIV.

Steps towards improvement

Improvements in health-care waste management rely on the following key elements:

- The build-up of a comprehensive system, addressing responsibilities, resource allocation, handling and disposal. This is a long-term process, sustained by gradual improvements;
- Awareness raising and training about risks related to health-care waste, and safe and sound practices;
- Selection of safe and environmentally-friendly management options, to protect people from hazards when collecting, handling, storing, transporting, treating or disposing of waste.

Government commitment and support is needed to reach an overall and long-term improvement of the situation, although immediate action can be taken locally. Health-care waste management is an integral part of health-care, and creating harm through inadequate waste management reduces the overall benefits of health-care.

The management of health-care waste requires increased attention and diligence to avoid the substantial disease burden associated with poor practice, including exposure to infectious agents and toxic substances. Incinerators provide an interim solution especially for developing countries where options for waste disposal such as autoclave, shredder or microwave are limited.

Whatever the technology used, best practice must be promoted to ensure optimal operation of the system. To reduce exposure to toxic pollutants associated with the combustion process such as dioxins, furans, co-planar PCBs, nitrogen and sulphur oxides as well as particulate matter and to minimize occupational and public health risks, "best practices" for incineration must be promoted, and must include the following elements:

- Effective waste reduction and waste segregation, ensuring that only appropriate wastes are incinerated;
- Siting incinerators away from populated areas or areas where food is grown, thus minimizing exposures and thereby risks;
- A properly engineered design, ensuring that combustion conditions are appropriate, e.g., sufficient residence time and temperatures to minimize products of incomplete combustion;
- Construction following detailed dimensional plans, thus avoiding flaws that can lead to incomplete destruction of waste, higher emissions, and premature failure of the incinerator;
- Proper operation, critical to achieving the desired combustion conditions and emissions. In summary, operation must: utilize appropriate start-up and cool-down procedures; achieve (and maintain) a minimum temperature before waste is burned; use appropriate loading/charging rates (both fuel and waste) to maintain appropriate temperatures; ensure proper disposal of ash; and ensure use of protective equipment to safeguard workers;
- Periodic maintenance to replace or repair defective components, including inspection, spare parts inventory, record keeping, and so forth;
- Enhanced training and management, possibly promoted by certification and inspection programmes for operators, the availability of an operating and maintenance manual, management oversight, and maintenance programmes.

Management and operational problems with incinerators, including inadequate training of operators, waste segregation problems, and poor maintenance, are recognized as critical issues that should be addressed in assessment and waste management plans.

Existing policy responses (Industrial and hazardous waste)

The MoEF, Government of India is the nodal agency at the central level for planning, promoting and co-ordinating environmental programmes, apart from policy formulation. The executive responsibilities for industrial pollution prevention, and control, are primarily executed by the CPCB at the central level,
which is a statutory authority, attached to the MoEF. The CPCB was constituted in September 1974, for implementing provisions of the Water (Prevention and Control of) Pollution Act, 1974. The State Departments of Environment
and SPCBs and Pollution Control Committees (PCCs) are the agencies designated
to perform these functions at the state and union territory level. Policies for hazardous waste management The Hazardous Wastes (Management and
Handling) Rules, 1989 was introduced under Sections 6, 8, and 25 of the Environment (Protection) Act of 1986 (referred to as HWM Rules 1989). The HWM Rules, 1989 provide for control of generation, collection, treatment,
transport, import, storage and disposal of wastes listed in the schedule annexed to
these rules. Implementation of these rules is done through the SPCBs and pollution control committees in respective states and union territories.

Initiatives taken for hazardous waste management

Emerging policy directions in the field of hazardous waste management emphasise the need for scientific disposal of waste and policies to encourage waste minimisation and adoption of cleaner technologies. Various activities initiated by the Government of India to meet these objectives are listed and discussed below:

_ MoEF has initiated task of hazardous waste inventory in various states to gather updated information

_ State governments are in the process of identifying hazardous waste disposal sites based on EIA of the potential sites

_ The CPCB has prepared a ready reckoner in 1998 providing technical information on sources of hazardous wastes, their characteristics, and the methods for recycling and disposal

_ Training programmes have been organized for concerned personnel in ports and customs and in pollution control boards so as to familiarise them with precautionary measures and testing methodologies for hazardous waste constituents.
_ It has been decided to impose a ban on import of hazardous wastes containing beryllium, selenium, chromium (hexavalent), thallium, pesticides, herbicides and their intermediates/residues based on recommendations by an Expert Committee constituted at the national level for advising in matters related to hazardous wastes
_ In order to control movement of Basel Wastes, cyanide wastes and mercury- and arsenic-bearing wastes have been prohibited for export and import from December 1996.
_ Import of waste oil and metal bearing wastes such as zinc ash, skimmings, brass dross and lead acid batteries for processing to recover resources would be regulated by MoEF and allowed only by environmentally acceptable technologies

E-waste related laws of India

Hazardous waste (Management and Handling) Amended Rules, 2003: These define hazardous waste as “any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger, or is likely to cause danger, to health or environment, whether alone or when on contact with other wastes or substances. “In Schedule 1, waste generated from the electronic industry is considered as hazardous waste.

DGFT (Exim policy 2002-07): The Director General of Foreign Trade under the Ministry of Commerce governs the EXIM policy, and as per the Para2.17 of EXIM Policy, 2002-07 which says: "All second hand goods shall be restricted for imports and may be imported only in accordance with the provisions of this policy, ITC (HS), Hand book (Vol.1), Public Notice or a licence/ certificate/ Permission issued in this behalf5."

Conclusion

Biomedical wastes pose considerable threat to our environment. As a health care professionals, it becomes our responsibility and obligation, legal and ethical, to dispose off biomedical wastes adequately. Barriers to biomedical waste management should be addressed to facilitate better results. Constant upgradation of our knowledge, skills and technology is the need of the hour.

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